

### REMARKS

Claims 1-27 were pending. Claims 1-11, 13, 15, 17-21, 23, 25, and 27 stand rejected. Claims 12, 14, 16, 22, 24, and 26 stand objected to. Claims 9-16 and 19-26 were amended. Claims 1-27 remain in the application.

The specification has been amended to add the word "of" to correct a grammatical error and to remove an incorporation by reference of a hyperlinked document.

The dependent claims have each been amended to delete an erroneous inclusive of the word "and".

Claims 12, 14, 16, 22, 24, and 26 stand objected to as being dependent upon a rejected base claim, but allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claims 12, 14, 22, and 24 have been so rewritten. Claims 16 and 26 are dependent upon Claims 14 and 24, respectively.

Claims 1-9, 13, 15, 17-21, 23, 25, and 27 stand rejected under 35 U.S.C. 102(e) as being anticipated by Khosla et al ("Khosla", U.S. 6,202,061).

Claim 1 states:

1. A digital image album layout system comprising:  
a page creator module having a first genetic engine operable to execute genetic evolution calculations on a first genetic population of image criteria, said page creator module having a page evaluation module operable to test said first genetic population for fitness to album preference criteria and  
an image placement module having a second genetic engine operable to execute genetic evolution calculations on a second genetic population of page layout criteria, said image placement module having a layout evaluation module operable to test said second genetic population for fitness to page preference criteria.

In relation to Claim 1, the rejection cites Khosla, col. 6, lines 11-12 and 16-19:

'the album authoring software determines the selected layout and style for the desired album' (col. 6, lines 11-12)

'the album authoring software determines the set of album pages based upon the selected layout. Further, the album authoring software assigns a

unique number to each slot on the ordered set of album pages.' (col. 6, lines 16-19)

Claim 1 requires a system having a page creator module and a an image placement module. The page creator module has a first genetic engine and a page evaluation module. The image placement module has a second genetic engine and a layout evaluation module. The term "engine" is used in an ordinary sense in relation to computer programs:

**'engine**

'1. the part of a computer program that implements a special technique' (Dictionary of Computer and Internet Terms, 8th ed., Barron's Educational Series, Inc., (2003), page 171)

The term "genetic", is also used in an ordinary sense in relation to computer programs:

**'genetic programming** A type of programming that imitates genetic algorithms, which uses mutation and replication to produce algorithms that represent the "survival of the fittest." While genetic algorithms yield numbers, genetic programs yield ever-improving computer programs. Written in languages such as LISP and Scheme, genetic programming requires the determination of a fitness function, which is a desired output (result). The degree of error in the fitness function determines the quality of the program.' (Computer Desktop Encyclopedia, 9th ed., Osborne/McGraw-Hill, New York, (2001), page 389)

Claim 1 requires two genetic engines. Khosla does not disclose a genetic engine. Khosla states:

'In step 263, the album authoring software determines the selected layout and style for the desired album. This will typically be performed by receiving input from a user, such as input derived from a graphical user interface for the layout and styles (see, for example, FIG. 12A). In step 265, the album authoring software determines the set of album pages based upon the selected layout.' (Khosla, col. 6, lines 10-17)

'FIG. 12A shows a graphical user interface provided by the album authoring software in one embodiment of the present invention. The window 801 is partially covered by the layout and style window 1201. The layout and style window 1201 allows a user to select a particular

layout from a list of various layouts 1203. This window also allows the user to select a particular style from a list of various styles 1205 shown in the window 1201. The preview window 1209 shows the currently selected layout and style.' (Khosla, col. 12, lines 20-28)

A graphical user interface that provides user input is not a genetic engine. Assuming for the sake of argument that Khosla suggested computer selection of layout and style, that still would not be a disclosure of a genetic engine. Computer selection could be as simple as use of default settings for layout and style or some other simple technique. That would arguably teach an "engine", but the claim requires "genetic engine".

Claim 1 also requires that the two genetic engines are separate. (application, page 15, lines 17-24) Where does Khosla disclose or suggest separate engines for these purposes?

Claim 1 also requires that the first genetic engine is operable to execute genetic evolution calculations on a first genetic population of image criteria and the second genetic engine is operable to execute genetic evolution calculations on a second genetic population of page layout criteria. What in Khosla would execute such calculations on such criteria?

Claim 1 also requires that the page creator module has a page evaluation module operable to test the first genetic population for fitness to album preference criteria and the image placement module has a layout evaluation module operable to test the second genetic population for fitness to page preference criteria. What in Khosla would do such testing?

Independent Claims 2-8, 17-18, and 27 are allowable, on the grounds discussed above in relation to Claim 1. These claims, most notably, each include a genetic engine or similar method steps and other features not disclosed or suggested in Khosla.

Claim 2 states:

2. An automated album layout method responsive to a set of inputs containing digital images, graphics, and other 2-dimensional objects, comprising the steps of:

evaluating a grouping of the image objects for distribution into a number of album pages according to a fitness function's parameters of a genetic engine;

assigning each image object to a page based on user preferences, including at least one of; balance, emphasis, chronology, and unity;

displaying said page for user viewing, and

refining the distribution based on further user action.

In relation to Claim 2, the rejection relies upon Khosla, col. 6, lines 16-17, which states:

'the album authoring software determines the set of album pages based upon the selected layout.' (col. 6, lines 16-17)

Unlike Khosla, Claim 2 requires 'evaluating a grouping of the image objects for distribution into a number of album pages according to a fitness function's parameters of a genetic engine'. Where does the determining disclosed by Khosla disclose or suggest evaluating according to fitness function's parameters of a genetic engine? (Also see the use of the term 'fitness function' in the above quoted definition of 'genetic programming'.)

Claim 3 states:

3. An automated layout and presentation method responsive to a set of inputs containing digital images, graphics, and other two-dimensional objects, comprising the steps of:

evaluating the 'x' and 'y' position coordinates, scale, and rotation of each of the input images objects within a page according to fitness function parameters in a genetic engine;

creating a page layout based on user preferences including at least one of; white space, overlap, rotation, spatial balance, rotational balance, border symmetry, and emphasis;

displaying said page layout for user viewing;

refining said page layout based on further user action, and

formatting the page layout printing.

The rejection refers to Khosla, col. 6, lines 31-41, which states:

'For example, picture 1 in the ordered list of pictures is placed into slot 1 which would typically be on page 1 of the album. Picture 2 in the ordered list of pictures is placed into slot 2 which may be on page 1 of the album or on page 2 of the album. This assignment is performed for all pictures in the ordered list of pictures currently selected by the user for this particular

album. In step 269, the album authoring software scales each picture if necessary to cause it to fit into the corresponding slot on the album page.

The aspect ratio of the picture is maintained after the scaling operation.'

Unlike Khosla, Claim 3 requires 'evaluating the 'x' and 'y' position coordinates, scale, and rotation of each of the input images objects within a page according to fitness function parameters in a genetic engine'. Where does the scaling disclosed by Khosla disclose or suggest evaluating according to fitness function parameters? (Also see the use of the term 'fitness function' in the above quoted definition of 'genetic programming'.)

Claim 4 states:

4. A system for assigning images to album pages,  
comprising:
  - means for specifying an initial set of image page assignments to a genetic population;
  - a genetic engine operable to evolve said genetic population to produce a present set of image page assignments;
  - a page evaluation module operable to test said present set of image page assignments according to an album fitness function to determine an album score, and
  - means for outputting said present set of image page assignments if said album score meets an album threshold value.

Unlike Khosla, Claim 4 requires 'a genetic engine operable to evolve said genetic population to produce a present set of image page assignments'. Claim 4 also requires 'means for specifying an initial set of image page assignments to a genetic population'; 'a page evaluation module operable to test said present set of image page assignments according to an album fitness function to determine an album score'; and 'means for outputting said present set of image page assignments if said album score meets an album threshold value.' (Also see the above discussion of Claim 1.)

Claim 5 states:

5. A system for arranging images on an album page,  
comprising:
  - means for specifying an initial set of image placement parameters to a genetic population;

a genetic engine operable to evolve said genetic population to produce a present set of image placement parameters;  
a layout evaluation module, operable to test said present set of image placement parameters with a page fitness function to determine a page score, and  
a means for outputting said image placement parameters if

said page score meets a page threshold value.

Unlike Khosla, Claim 5 requires 'a genetic engine operable to evolve said genetic population to produce a present set of image placement parameters'. Claim 5 also requires 'means for specifying an initial set of image placement parameters to a genetic population'; 'a layout evaluation module, operable to test said present set of image placement parameters with a page fitness function to determine a page score'; and 'a means for outputting said image placement parameters if said page score meets a page threshold value'. (Also see the above discussion of Claim 1.)

Claim 6 states:

6. A system for assigning and placing images on album pages, comprising:

means for specifying an initial set of image page assignments to a first genetic population;

a first genetic engine operable to evolve said first genetic population to produce a present set of image page assignments;

a page evaluation module operable to test said present set of image page assignments according to an album fitness function to determine an album score;

means for outputting said present set of image page assignments if said album score meets an album threshold value;

means for specifying an initial set of image placement parameters to a second genetic population in accordance with said outputted set of image page assignments;

a second genetic engine operable to evolve said second genetic population to produce a present set of image placement parameters;

a layout evaluation module operable to test said present set of image placement parameters with a page fitness function to determine a page score, and

means for outputting said image placement parameters if said page score meets a page threshold value.

Unlike Khosla, Claim 6 requires 'a first genetic engine operable to evolve said first genetic population to produce a present set of image page assignments' and 'a second genetic engine operable to evolve said second genetic population to produce a present set of image placement parameters'. Claim 6 also requires 'means for specifying an initial set of image page assignments to a first genetic population'; 'a page evaluation module operable to test said present set of image page assignments according to an album fitness function to determine an album score'; 'means for outputting said present set of image page assignments if said album score meets an album threshold value'; 'means for specifying an initial set of image placement parameters to a second genetic population in accordance with said outputted set of image page assignments'; 'a layout evaluation module operable to test said present set of image placement parameters with a page fitness function to determine a page score'; and 'means for outputting said image placement parameters if said page score meets a page threshold value'. (Also see the above discussion of Claim 1.)

Claim 7 states:

7. A method of assigning images to album pages,  
comprising the steps of:  
specifying an initial set of image page assignments to a  
genetic population;  
evolving said genetic population to produce a present set of  
image page assignments;  
testing said present set of image page assignments  
according to an album fitness function to determine an album score, and  
outputting said present set of image page assignments if  
said album score meets an album threshold value.

Unlike Khosla, Claim 7 requires 'specifying an initial set of image page assignments to a genetic population, and evolving said genetic population to produce a present set of image page assignments'. Claim 7 also requires

'specifying an initial set of image page assignments to a genetic population';  
'testing said present set of image page assignments according to an album fitness function to determine an album score'; and 'outputting said present set of image page assignments if said album score meets an album threshold value.' (Also see the above discussion of Claim 4.)

Claim 8 requires:

8. A method of assigning a plurality of images, having image parameters, to one or more pages in an album, comprising the steps of:

specifying an initial set of page assignments defining the album page assignment for each of the plurality of images;

initializing a genetic population by assigning said initial set of page assignments to genes within an album genome structure;

evolving said genetic population in accordance with a genetic function to produce a present set of page assignments within said album genome structure;

calculating a present set of page criteria according to said present set of page assignments, the image parameters, and a set of album page parameters;

testing said present set of page criteria according to an album fitness function to determine an album score;

repeating said evolving and calculating steps if said album score fails to meet an album threshold value, and

outputting image page assignments according to said present page assignment if said album score meets said album threshold value.

The rejection refers to Khosla, column 6, lines 3-6:

'picture album authoring software determines an ordered list of pictures for a desired album. Typically, the user will have selected certain pictures for a desired album and these pictures are put in an ordered list.'

In Claim 8, assignments, not images, are assigned to genes within an album genome structure. Where does the assignment to an ordered list of Khosla disclose or suggest assignment of an initial set of page assignments to genes within an album genome structure? (See application, page 12, lines 26-28; also

see the discussion below of Claims 20-21 as to the issue that an arrangement of images is not a genome structure.)

The rejection also refers to Khosla, col. 6, lines 10-15, 16-19, and 19-21:

In step 263, the album authoring software determines the selected layout and style for the desired album. This will typically be performed by receiving input from a user, such as input derived from a graphical user interface for the layout and styles (see, for example, FIG. 12A). In step 265, the album authoring software determines the set of album pages based upon the selected layout. Further, the album authoring software assigns a unique number to each slot on the ordered set of album pages. Then in step 267, the album authoring software assigns the ordered list of pictures to the numbered slots of the album pages.' (Khosla, col. 6, lines 10-21)

Unlike Khosla, Claim 8 requires 'evolving said genetic population in accordance with a genetic function to produce a present set of page assignments within said album genome structure'. Claim 8 also requires 'initializing a genetic population by assigning said initial set of page assignments to genes within an album genome structure'; 'calculating a present set of page criteria according to said present set of page assignments, the image parameters, and a set of album page parameters'; 'testing said present set of page criteria according to an album fitness function to determine an album score'; 'repeating said evolving and calculating steps if said album score fails to meet an album threshold value'; and 'outputting image page assignments according to said present page assignment if said album score meets said album threshold value.' (Also see the above discussions of fitness function and of genetic programming.)

Claims 9, 13, and 15 are allowable as depending from Claim 8 and as follows.

Claim 9 states:

9. The method of Claim 8 wherein said image parameters include an image event value, image chronology value, and image emphasis value.

The rejection states, in relation to Claim 9:

'As per claim 9, which is dependent on claim 8, it is inherent in Khosla's system that the image parameters include an image event value, image chronology value and image emphasis value.'

Why is it inherent? The repeated phrase, in Khosla, 'the album authoring software determines' (col. 6, lines 3, 11, 16) does not disclose or suggest a procedure that makes use of particular image parameters. There is an explanation, but that explanation is that "typically", the system relies upon user input. (Khosla, col. 6, lines 4-5 and 12-13) User input features are shown in Khosla, Figure 12A.

Where do the features shown in Figure 12A provide for the indicated parameters? Where would Khosla use specific image parameters in calculating a present set of page criteria, followed by testing the page criteria according to an album fitness function, as required by Claim 9? (citing language from Claim 8) Where does Khosla disclose or suggest an image event value, image chronology value, and image emphasis value that are used as image parameters?

Claim 13 states:

13. The method of Claim 8 wherein calculation of said page criteria includes calculation of an emphasis value range, a page count value, and a balance threshold value.

The rejection states:

'As per claim 13, which is dependent on claim 8, Khosla teaches a calculation of said page criteria includes an emphasis value range, a page count value range, and a balance threshold value (col. 6, lines 16-19)

The cited portion of Khosla states:

'the album authoring software determines the set of album pages based upon the selected layout. Further, the album authoring software assigns a unique number to each slot on the ordered set of album pages.' (Khosla, col. 6, lines 16-19)

The rejection again relies upon the phrase 'album authoring software determines' as teaching features not otherwise disclosed. As discussed above in relation to Claim 9, this reliance is misplaced. "Typically", the system of Khosla relies upon user input. (Khosla, col. 6, lines 4-5 and 12-13) In Khosla, Figure 12A, the user interface shows the layout "Two Picture" and style "Marble" with two image slots in a particular arrangement. (also see col. 12, lines 20-32) Selected pictures are

placed in slots in order. (Khosla, col. 6, lines 19-25) Where is a calculation necessary? Where does Khosla disclose or suggest a calculation of page criteria including a calculation of an emphasis value range, a page count value, and a balance threshold value? Note the testing of page criteria required by Claim 8.

Claim 15 states:

15. The method of Claim 8 wherein said page criteria includes balance, emphasis, chronology, and unity.

In relation to Claim 15, the rejection states:

'As per claim 15, which is dependent on claim 8, it is inherent in Khosla's system that the page criteria includes balance, emphasis, chronology, and unity.'

The arguments presented in relation to Claim 9 and 13 are applicable here. The rejection again relies upon the phrase 'album authoring software determines' as teaching features not otherwise disclosed. Where does Khosla disclose or suggest page criteria that include balance, emphasis, chronology, and unity? Note the testing of page criteria required by Claim 8.

Claim 17 states:

17. A method of arranging images on an album page, comprising the steps of:  
specifying an initial set of image placement parameters to a genetic population;  
evolving said genetic population to produce a present set of image placement parameters;  
testing said present set of image placement parameters with a page fitness function to determine a page score; and  
outputting said image placement parameters if said page score meets a page threshold value.

Claim 17 requires 'specifying an initial set of image placement parameters to a genetic population;' and 'evolving said genetic population to produce a present set of image placement parameters'. The application states:

'The present invention employs a novel approach to page layout by employing genetic algorithms, which are a class of adaptive methods that can be used to solve search and optimization problems involving large search spaces. The search is performed using a simulated

evolution (survival of the fittest). These algorithms maintain and manipulate "generations" of potential solutions or "populations". With each generation, the best solutions (as determined by a problem specific fitness function) are genetically manipulated to form the solution set for the following generation. As in real evolution, solutions can be combined (via mating/crossover) or undergo random mutation. In addition, inferior solutions can, by chance, survive from generation to generation.' (application, page 11, line 23 to page 12, line 3; emphasis added; also see "survival of the fittest" in above-quoted definition of genetic programming)

Khosla does not disclose or suggest specifying parameters to a genetic population nor evolving that genetic population. (Also see above discussion of Claim 1.)

Claim 18 states:

18. A method of arranging one or more images, having image parameters, on an album page, comprising the steps of:  
specifying an initial set of positioning parameters for each of the one or more images;  
initializing a genetic population by assigning said initial set of positioning parameters as genes in a page genome structure;  
evolving said genetic population in accordance with a genetic function to produce a present set of positioning parameters within said page genome structure;  
calculating a set of present layout criteria, according to said present set of positioning parameters, the image parameters, and a set of page layout parameters;  
testing said present set of layout criteria according to a page fitness function to determine a page score;  
repeating said evolving and calculating steps if said page score fails to meet a page threshold value; and  
outputting a page layout according to said present set of positioning parameters if said page score meets said page threshold value.

The rejection cited Khosla col. 6, lines 10-15, 19-21, and 19-29:

'In step 263, the album authoring software determines the selected layout and style for the desired album. This will typically be performed by

receiving input from a user, such as input derived from a graphical user interface for the layout and styles (see, for example, FIG. 12A).' (lines 10-15)

'Then in step 267, the album authoring software assigns the ordered list of pictures to the numbered slots of the album pages. For example, picture 1 in the ordered list of pictures is placed in slot 1 which would typically be on page 1 of the album. Picture 2 in the ordered list of pictures is placed into slot 2 which may be on page 1 of the album or on page 2 of the album. This assignment is performed for all pictures in the ordered list of pictures currently selected by the user for this particular album. In step 269, the album authoring software scales each picture if necessary to cause it to fit into the corresponding slot on the album page.' (lines 10-30)

Claim 18 requires 'initializing a genetic population by assigning said initial set of positioning parameters as genes in a page genome structure; evolving said genetic population in accordance with a genetic function to produce a present set of positioning parameters within said page genome structure; testing said present set of layout criteria according to a page fitness function to determine a page score. Claim 18 is allowable on the grounds discussed above in relation to Claim 17. (Also see the discussion of Claim 1 and of "fitness function" in relation to Claims 3-5)

Claims 19-21, 23 and 25 are allowable as depending from Claim 18 and as follows.

Claim 19 requires:

19. The method of Claim 18 wherein said image parameters include an image emphasis value.

Claim 19 is also allowable on the grounds discussed above in relation to Claim 9. Where does Khosla disclose an image emphasis value?

Claims 20-21 require:

20. The method of Claim 18 wherein said genome structure is an array.

21. The method of Claim 18 wherein said genome structure is selected from one of a tree structure, an array structure or a list structure.

The rejection states:

'As per claim 20, which is dependent on claim 18, Khosla teaches the genome structure is an array (the layout of pictures as in fig. 14 is an array).

'As per claim 21, which is dependent on claim 18, this claim is rejected under the same rationale as claim 20.'

Claim 18, from which Claims 20-21 depend, states:

'initializing a genetic population by assigning said initial set of positioning parameters as genes in a page genome structure;

'evolving said genetic population in accordance with a genetic function to produce a present set of positioning parameters within said page genome structure'. (emphasis added)

The application states:

'The data structure used by a genetic algorithm is known as a genome. In the coding, task, a data structure is chosen to represent the genome for the problem space and a mapping from the data structure fields to the problem domain is established.' (application, page 12, lines 26-28; also see page 18, line 21 to page 19, line 12)

A layout of images is not a genome structure.

27. A method of assigning and placing images on album pages, comprising the steps of:

specifying an initial set of image page assignments to a first genetic population;

evolving said first genetic population to produce a present set of image page assignments;

testing said present set of image page assignments according to an album fitness function to determine an album score;

outputting said present set of image page assignments if said album score meets an album threshold value;

specifying an initial set of image placement parameters to a second genetic population in accordance with said outputted set of image page assignments;

evolving said second genetic population to produce a present set of image placement parameters;

testing said present set of image placement parameters with a page fitness function to determine a page score; and outputting said image placement parameters if said page score meets a page threshold value.

Claim 18 requires: 'specifying an initial set of image page assignments to a first genetic population; evolving said first genetic population to produce a present set of image page assignments; testing said present set of image page assignments according to an album fitness function to determine an album score;' and 'specifying an initial set of image placement parameters to a second genetic population in accordance with said outputted set of image page assignments; evolving said second genetic population to produce a present set of image placement parameters; testing said present set of image placement parameters with a page fitness function to determine a page score'. Claim 18 requires two genetic populations and has separate evolving steps for each population. This is not taught by Khosla. (Also see above discussion of Claim 1.) Claim 18 also requires two separate steps of testing with album and page fitness functions. This is not taught by Khosla. (Also see above discussion of Claims 3-5 and 17-18)

Claims 10 and 11 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Khosla in view of Wang (U.S. 6,014,458). The rejection stated:

'As per claim 10, which is dependent on claim 8, Khosla does not disclose the genome structure is a tree structure. Wang discloses hierarchical tree structure for arranging images in document pages in and fig. 8, lines 27-45. It would have been obvious to an artisan at the time of the invention to use the teaching from Wang of the genome structure is a tree structure in Khosla's system since it would allow a user easily to arrange and organize images in pages.'

'As per claim 11, which is dependent on claim 8, it is rejected under the same rationale as claim 10.' (It is believed that Wang, col. 6, lines 27-45 was intended to be referred to in the above.)

Claims 10-11 state:

10. The method of Claim 8 wherein said genome structure is a tree structure.

11. The method of Claim 8 wherein said genome structure is selected from one of a tree structure, an array structure, or a list structure.

Claims 10-11 are allowable as depending from Claim 8 and on grounds discussed above in relation to Claims 8 and 20-21. Claims 10 and 11 require that a genome structure has a particular structure. A genome structure is not a layout of images, as discussed above, in relation to Claims 8 and 20-21. Claims 10-11 are also allowable, because one of skill in the art would not be motivated to combine Khosla and Wang. Khosla discloses an array of pictures in Figure 14. Wang discloses block selection in a page analysis system. Figure 8 shows placement of hierarchical tree structures within pages of memory. (Wang, col. 6, lines 38-39) The hierarchical tree structures are discussed as having a root node that represents an entire page and additional nodes assigned to text and non-text connected components. (Wang, col. 7, lines 45-50 and col. 8, lines 36-39) The non-text components are analyzed and assigned to another layer of nodes based on whether they are lines, pictures, frames, tables, etc. (Wang, col. 8, lines 49-52) How could Khosla and Wang be combined?

It is believed that these changes now make the claims clear and definite and, if there are any problems with these changes, Applicants' attorney would appreciate a telephone call.

In view of the foregoing, it is believed none of the references, taken singly or in combination, disclose the claimed invention. Accordingly, this application is believed to be in condition for allowance, the notice of which is respectfully requested.

Respectfully submitted,



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Enclosures: Pages from Dictionary of Computer and Internet Terms  
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# Dictionary of Computer and Internet Terms

Eighth Edition

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$$\begin{aligned} K &= A^b \bmod n \\ &= 16^6 \bmod 37 \\ &= 16, 777, 216 \bmod 37 \\ &= 10 \end{aligned}$$

Notice that this is the same value even though it is calculated from different numbers using a different formula. This works because of the following mathematical identities:

$$(a \times b) \bmod n = [(a \bmod n) \times (b \bmod n)] \bmod n$$

$$\begin{aligned} a^c \bmod n &= (a \bmod n)^c \bmod n \\ a^{bc} &= (a^b)^c = (a^c)^b \end{aligned}$$

$$\begin{aligned} a^{bc} \bmod n &= (a \bmod n)^{bc} \bmod n \\ &= [(a \bmod n)^b]^c \bmod n \\ &= [(a \bmod n)^c]^b \bmod n \end{aligned}$$

$$\begin{aligned} a^{bc} \bmod n &= (a \bmod n)^{bc} \bmod n = (a^c \bmod n)^b \bmod n \\ a^{bc} \bmod n &= (a \bmod n)^{bc} \bmod n = (a^b \bmod n)^c \bmod n \end{aligned}$$

To calculate the private key (equivalent to  $c$ ), given the public key and the session key, you need to solve an equation of this general form:

$$k = j^x \bmod n$$

If  $n$  happens to be a large prime number, it is very difficult to discover the value of  $x$  even if you know the values of  $k$ ,  $j$ , and  $n$ . Thus, large prime numbers play a crucial role in public-key encryption.

In practice, when computers are used for encryption, the calculations are usually carried out directly on the binary digits of the data, using a key given as a binary number. A longer key provides greater security, but the calculation process becomes more complicated.

All this presumes that you can get people's public keys reliably so that you can be sure you're really using Bob's public key when you send messages to Bob. Since public keys are not secret, all you need is a trustworthy database in which you can look up people's public keys.

Until 2000, the U.S. government regulated the export of strong encryption software in the same way that it regulates the export of weapons. This regulation dated from the 1940s, before general-purpose digital computers existed; encryption machines at that time were considered to be military devices.

See *also* DIGITAL SIGNATURE; DES; PGP; RSA ENCRYPTION; SSL; ONE-WAY FUNCTION; HASH FUNCTION.

end

1. keyword that marks the end of a particular program structure in several programming languages. In BASIC, the END keyword tells the computer to stop executing the program. In Pascal, END marks the end of blocks of statements that start with BEGIN.

2. the key on your keyboard that takes your cursor to the end of the current line. Some word processors use Ctrl-End as a keyboard shortcut to take you to the end of the document.

**en dash** a short dash (–). See DASH.

**end-of-file mark** a symbol that indicates the end of a file. For example, in CPM, all text files ended with ASCII character 26 (Ctrl-Z) because the computer did not otherwise keep track of the exact length of the file, only the number of disk sectors. In DOS, Windows, and OS/2, Ctrl-Z is often used the same way even though the computer knows exactly where the file ends whether or not an end-of-file mark is present. The UNIX end-of-file mark is Ctrl-D (ASCII 4).

**end user** the person ultimately intended to use a product, as opposed to people involved in developing or marketing it.

**Energy Star** a set of guidelines proposed by the U.S. Environmental Protection Agency in 1992 to reduce the amount of electricity consumed by personal computers. An Energy Star-compliant computer consumes less than 30 watts of power when idling (i.e., when turned on but not in use) and switches automatically into low-power mode if several minutes elapse without any keyboard activity. See GREEN PC.

engine

1. the part of a computer program that implements a special technique; see INFERENCE ENGINE, MONTE CARLO ENGINE, SEARCH ENGINE.

2. the printing mechanism of a laser printer, not including the computer control circuitry. Many laser printers use an engine made by Canon in Japan.

**ENIAC** (Electronic Numerical Integrator And Calculator) one of the first electronic computers, built at the University of Pennsylvania in the mid-1940s. It contained about 18,000 vacuum tubes. Initially, the ENIAC was programmed by plugging cables into circuit boards. Today, one of the Internet nodes at the University of Pennsylvania is named eniac but is, of course, not the same machine.

**Enter key** the key on a computer keyboard that you press at the end of each line in order to send the contents of that line into the computer. On most keyboards, the Enter key is the same as the Return key. However, IBM 3270-series terminals make a distinction: the Return key starts a new line, but the Enter key sends the contents of the whole screen to the computer.

Under windowed operating systems, pressing the Enter key is usu-



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R. L. WALKER



# Computer Desktop Encyclopedia

**Ninth Edition**

Alan Freedman

Osborne/McGraw-Hill

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New York Chicago San Francisco

London Madrid Mexico City Milan

New Delhi Hong Kong Seoul Singapore Sydney Toronto

To my mother, who had the vision to send me  
to "automation school" in 1960.

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**General MIDI** A standard set of 128 sounds for MIDI sound cards and devices (synthesizers, sound modules, etc.). By assigning instruments to specific MIDI patch locations, General MIDI provides a standard way of communicating MIDI sound.

MIDI's small storage requirement makes it very desirable as a musical sound source for multimedia applications compared to digitizing actual music. For example, a three-minute MIDI file may take only 20 to 30K, whereas a WAV file (digital audio) could consume up to several megabytes depending on sound quality.

**General Protection Fault** See *GPF*.

**General Public License** See *GNU General Public License*.

**general-purpose computer** Refers to computers that follow instructions, thus virtually all computers from micro to mainframe are general purpose. Even computers in toys, games and single-function devices follow instructions in their built-in program. In contrast, computational devices can be designed from scratch for special purposes (see *ASIC*).

**general-purpose controller** A peripheral control unit that can service more than one type of peripheral device; for example, a printer and a communications line.

**general-purpose language** A programming language used to solve a wide variety of problems. All common programming languages (C, C++, Java, COBOL, etc.) are examples. Contrast with *special-purpose language*.

**general-purpose machine** See *general-purpose computer*.

**generation X** Refers to individuals roughly between the age of 25 and 34. "Generation Y" pertains to ages 18 to 24, and "baby boomers" are people 35 to 54. By the time older gen-Xers became teenagers, the personal computer revolution had begun. Younger gen-Xers and all generation Ys were brought up in the thick of it. In contrast, older baby boomers were certainly raised without desktop computers, but many did not even have TVs as a child.

**generation Y** See *generation X*.

**generator** (1) Software that creates software. See *application generator* and *macro generator*.  
(2) A device that creates electrical power or synchronization signals.

**Generic CADD** A full-featured CADD package for DOS from Autodesk, Inc., Sausalito, CA ([www.autodesk.com](http://www.autodesk.com)), that offers levels for beginner, intermediate and advanced users. It was originally developed by Generic Software of Bothell, WA.

**generic top-level domain** See *Internet domain name*.

**genetic programming** A type of programming that imitates genetic algorithms, which uses mutation and replication to produce algorithms that represent the "survival of the fittest." While genetic algorithms yield numbers, genetic programs yield ever-improving computer programs. Written in languages such as LISP and Scheme, genetic programming requires the determination of a fitness function, which is a desired output (result). The degree of error in the fitness function determines the quality of the program. For more information, visit [www.geneticprogramming.com](http://www.geneticprogramming.com).

**Genie** An online information service from Yovelle Renaissance Corporation ([www.genie.com](http://www.genie.com)), that provides Internet access, chat lines, roundtable discussions and games. It was originally the General Electric Network for Information Exchange. See *online services*. See also *Jini*.

**genlock** (generator lock) Circuitry that synchronizes video signals for mixing. In personal computers, a genlock display adapter converts screen output into an NTSC video signal, which it synchronizes with an external video source.

**GEO** (Geostationary Earth Orbit) A communications satellite in orbit 22,282 miles above the equator. At this orbit, it travels at the same speed as the earth's rotation, thus appearing stationary. GEOs are excellent for TV broadcasting,